Organization: **California Institute of Technology**

MTO Simbiosys

Title: BioNEMS: Biofunctionalized Nanoelectromechanical Systems

Start Date: January 2002 **End Date:** January 2005

Principal Investigator(s): **Prof. Michael L. Roukes**
Phone: (626) 395-2916 Email: roukes@caltech.edu
Web: www.its.caltech.edu/~nano/

Project Goals

To develop ultrasensitive, nanometer-scale, force assays allowing molecular recognition of specific biochemical targets.

Technical Approach

- Development of nanometer-scale cantilevers with high mechanical compliance, and high force sensitivity in fluidic media. This includes staged development of integrated, ultrasensitive electrical displacement transducers and, subsequently, integrated electrical actuators. Initial efforts will focus upon individual cantilevers; subsequent efforts will be directed on small arrays.
- Development of surface biofunctionalization techniques allowing selective biochemical activation and passivation of desired regions. This includes staged development of approaches enabling uniform biofunctionalization, and subsequently, local biofunctionalization with submicron-scale resolution.
- Development of theoretical and numerical models for nanomechanical cantilevers in fluidic media. This includes detailed understanding of the properties of individual systems, and subsequently modeling of the fluctuations and correlations of multiple cantilever systems.
- Development of informatics techniques for signature recognition for force based assays. This includes development of numerical protocol for molecular recognition algorithms by passive, stochastic force sensing, and subsequently force transmission involving active, driven BioNEMS.
- Development of theoretical and numerical models for detailed biophysical processes crucial to BioNEMS operation. Among such processes are: stochastic force fluctuations in inhomogeneous fluids, e.g. aqueous media comprising macromolecular analytes; and biomolecular force transmission processes.

Recent Accomplishments

- New start

Six-Month Milestones

- Demonstration of nanocantilever properties in vacuum and fluidic media.
- Development of techniques for uniform biofunctionalization.
- Development of theoretical and numerical models for individual fluid loaded nanocantilevers (in homogeneous solutions).

Team Member Organizations

Prof. Scott E. Fraser, Biology, Caltech
Prof. Michael C. Cross, Physics, Caltech
Dr. Jerry E. Solomon, Beckman Institute of Biology, Caltech
Prof. Dan E. Meiron, Applied Mathematics, Caltech
Prof. Rob Phillips, Mechanical Engineering, Caltech
Prof. Raul Radovitzky, Applied Mathematics, MIT

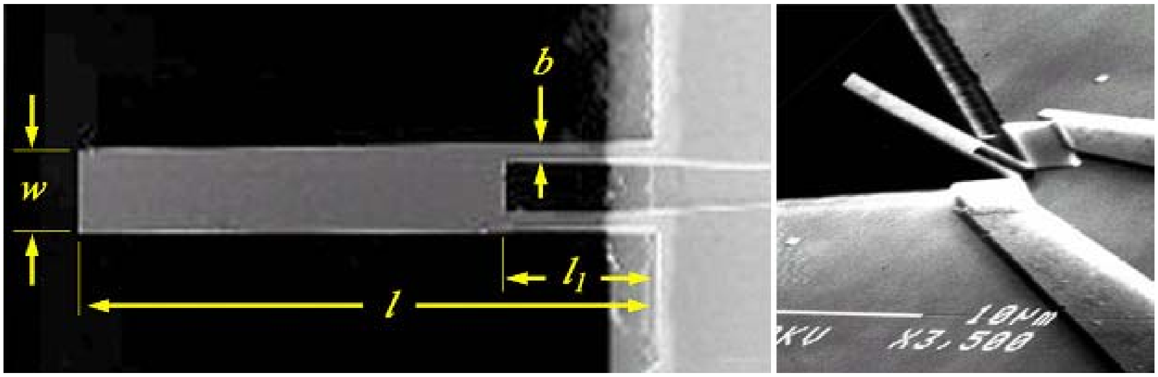

Figure 1: Single-crystal silicon nanocantilevers with integrated piezoresistive readout.

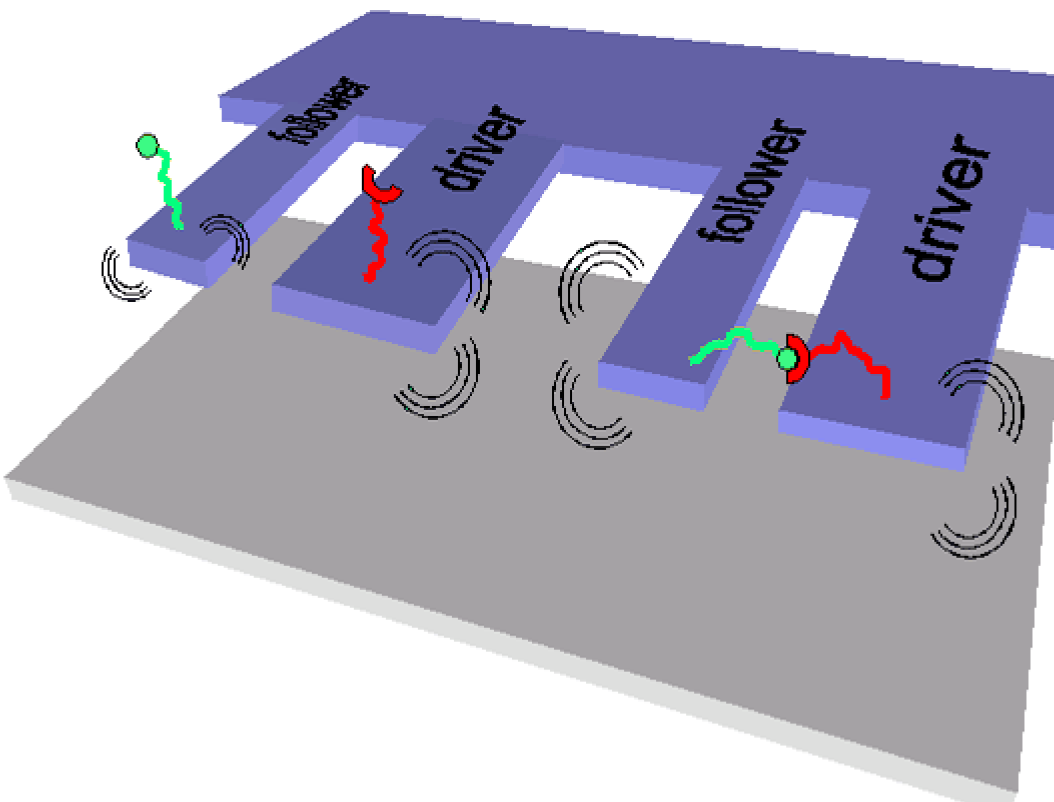

Figure 2: Conceptual schematic of molecular recognition through biofunctionalized nanoelectromechanical systems (BioNEMS). © Caltech 2002